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Pinus Strobus

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THE ASSOCIATES, through whose interest and generosity *The Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum.

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Arboretum Activities

It is with deep regret that we record the death on July 25th of Miss Janet L. Bowen, Administrative Assistant of the Arboretum. Miss Bowen had served the University in a number of important capacities and came to the Arboretum as Assistant to the Director on July 1, 1954. Her gracious personality and administrative ability will be sadly missed by members of the staff and visitors to the Arboretum.

PATHOLOGIST JOINS STAFF

On July 1st, Dr. Patricia Allison joined the Staff of the Arboretum as Plant Pathologist. This is a joint appointment by the Arboretum and the Department of Botany of the University.

Dr. Allison did her undergraduate work at the University of Houston and received her master's and doctor's degrees at Ohio State University.

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We Need Better White Pines for the Northeast

ERNST J. SCHREINER[1]

Thirty or forty years ago the title of this article undoubtedly would have met considerable argument from foresters, lumbermen, and landowners. In colonial days our eastern white pine *(Pinus Strobus)* provided some of the finest lumber for a multitude of uses; the King's Arrow could be found on many majestic white pines reserved for masts for the English navy. Nature had taken a long time to grow those magnificent specimens. Poor-quality trees probably existed in the same proportion as today, but there was such a large natural reserve of white pine that the poor trees could be figuratively "thrown away".

Although eastern white pine has been the most important species for reforestation in New England, it has begun to fall into disrepute because of its susceptibility to white pine blister rust and to the white pine weevil. Foresters and land owners have come to accept blister rust and the necessity for its control as a part of white pine management. But the threat of white pine weevil, which seriously impairs the timber quality and for which there is, as yet, no really satisfactory control, has curtailed the use of this species for reforestation in recent years.

We need an insect- and disease-resistant white pine, but this does not necessarily mean a better eastern white pine. Our conception of a better white pine should be a disease- and insect-resistant tree with growth and wood properties similar to, or better than, our native species. This could be a strain obtained by selection and pedigree breeding with our native stock, a new type derived by hybridization, or it could even be an exotic white pine species.

How can we get better white pines? By the same basic methods plant breeders have used to improve our agricultural plants. Research during the past 20 years has shown that we do have native white pines with sufficient inherent resistance to blister rust to warrant the assumption that we can develop resistant types by selective breeding within the species. We cannot today predict the possibilities of developing a weevil resistant eastern white pine without hybridiza-

[1]In charge, Forest Genetics Research, Northeastern Forest Experiment Station, maintained by the Forest Service, United States Department of Agriculture. The forest genetics work is in cooperation with the Morris Arboretum of the University of Pennsylvania at Philadelphia, Pennsylvania.

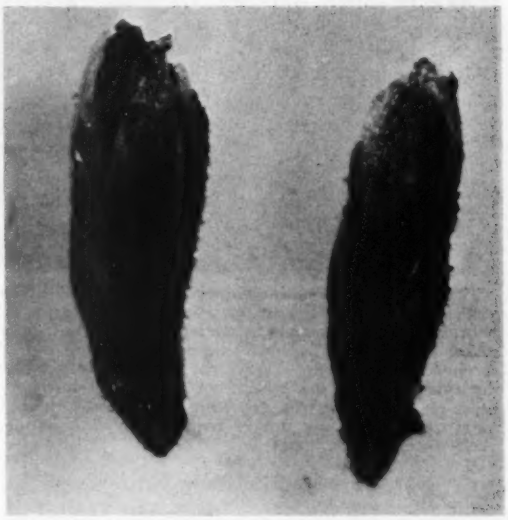

Fig. 21. Female flowers (strobili) of eastern white pine at the "bud bursting stage". Female flowers to be used for controlled pollination should be bagged at this stage. (Magnification approximately × 5.) (U. S. Forest Service Photo)

Fig. 22. Male flowers (strobili) of eastern white pine. (Magnification approximately × 2). The flowers at lower right are not yet shedding pollen; lower left just beginning to shed. Short twigs with male flowers at either of these stages may be cut and placed in water for collection of pollen. The flowers at top right and center are shedding pollen profusely. At this stage they may be removed and placed on paper for collection of pollen. The pollen has been completely shed from the strobili at upper left. (U. S. Forest Service Photo)

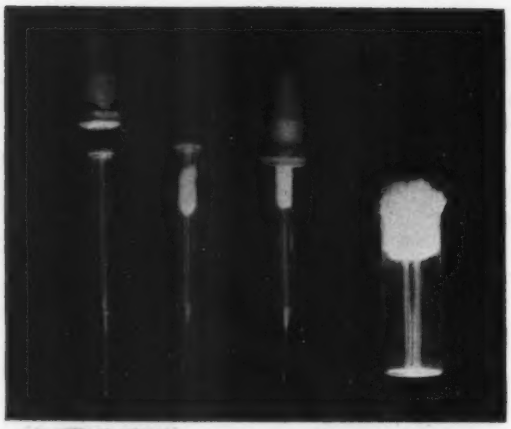

Fig. 23. Pollen from individual trees can be kept in small vials stoppered with cotton and can be applied with a medicine dropper, preferably drawn out to a rather fine point. The small cotton plug at the top of the medicine dropper prevents the pollen from entering the rubber bulb. Pine pollen can usually be stored for short periods during the breeding season under normal room conditions. Long storage requires special handling. (U. S. Forest Service Photo)

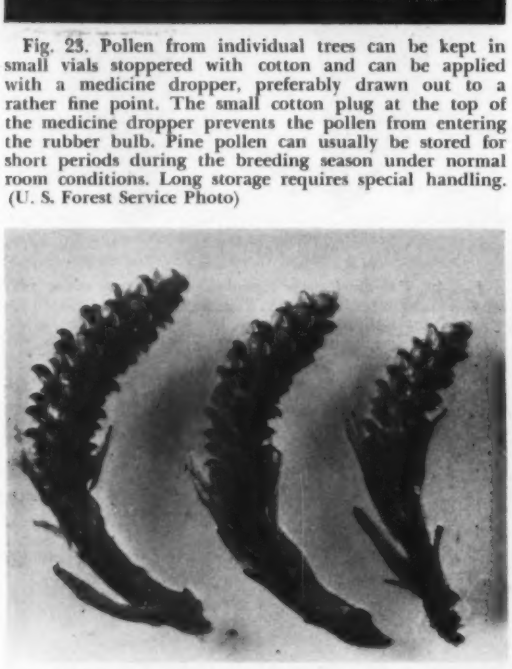

Fig. 24. Female flowers of white pine at the receptive stage. It is at this stage of development that the pollen should be applied for maximum seed-set. (Magnification approximately × 2.5.) (U. S. Forest Service Photo)

tion with other species. The search for, and testing of eastern white pines that appear to be resistant to the weevil has been started so recently that we cannot say definitely that there are (or are not) inherently resistant trees in our forests and plantations.

We have several approaches available for obtaining inherently better white pines for reforestation. Racial variation occurs in most tree species that have a wide geographic range and this appears to be the case in eastern white pine. The Northeastern Forest Experiment Station, in cooperation with the Southeastern, Central, and Lakes States Forest Experiment Stations of the U. S. Forest Service, and the Southern Research Station of the Ontario Department of Lands and Forests, has started a racial test which covers the entire range of eastern white pine. Within the next 10 years this range-wide test should indicate whether or not there are distinct races, and the probable adaptability of such races throughout the Northeastern region.

Selection of superior individual trees in natural stands and in plantations is also underway at the present time. Such superior trees can be used in breeding and they can also be grafted and grown in isolated seed orchards, plantations designed to produce superior seed for commercial use. The technique for establishing such seed plantations and for testing the individual selections for their breeding quality is beyond the scope of this paper.

Trees superior in resistance to pests, growth rate or timber form have been used in our

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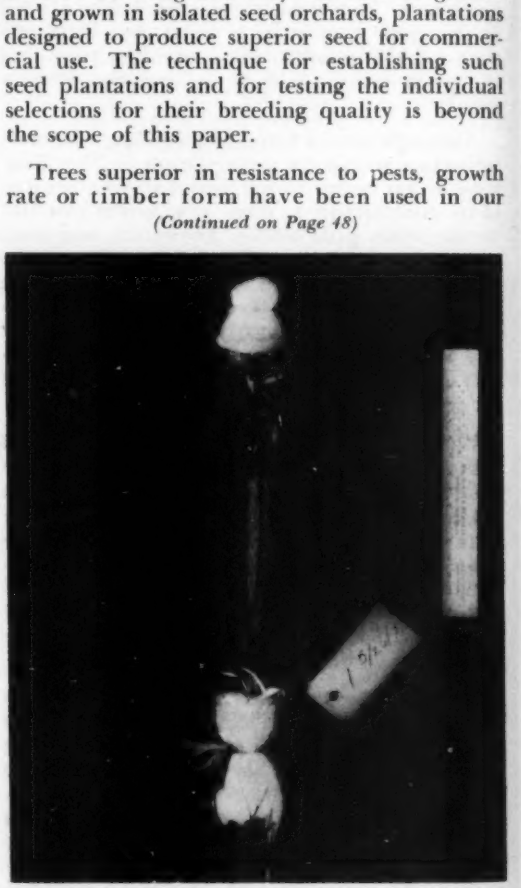

Fig. 25. Female flowers bagged with sausage casing for controlled pollination. The pollen may be dusted on the female flowers (when they are receptive) by puncturing the bag with a medicine dropper and then sealing the hole with scotch tape. Note that the individual flowering branch is tagged to identify the parentage of the controlled pollination. Cotton is wrapped around the twig to keep wind-blown pollen out of the bag. (U. S. Forest Service Photo)

What's Your Trouble?

PATRICIA ALLISON

Surely there can be no more exquisite anguish than that of the gardener with trouble. Usually this distress does not lie in the fact that the living vista he is trying to create falls just short of the glories of the seed catalog or the splendors of the home magazine. To the contrary, the real trouble comes when his personal struggle with nature seems to be swinging in the wrong direction – toward actual loss of the green objects of his labor to say nothing of his investment. This type of trouble does not include damage by hurricanes, fires or small boys with hatchets, which is vastly more acceptable than his real troubles. No, the causes of genuine worry seem mysterious beyond measure and remediable only through some rare and thoroughly random stroke of luck. They are PLANT DISEASES AND PESTS. His principal object, then, is to increase his chances of successful remedy and his doubts about how to proceed are certainly justifiable.

Many have long been aware that such pests as insects can cause really grave damage to all sorts of plants. Even now, however, not many who are non-gardeners even know that plants can be diseased, let alone that diseases cause about three billion dollars worth of damage in the United States each year. The arrays of garden chemicals in hardware and department stores are doing much to create awareness as well as to provide means for control. They have also done much to create confusion. "What shall I buy?" "Should I buy a fungicide or an insecticide?" are questions commonly heard by specialists in retail merchandising. The answers to these questions and many like them depend wholly on knowing the cause of the trouble. Only with at least a general knowledge of causes can a general notion of remedies be formed. And before we can gain a general awareness of causes of trouble we must become skilled in seeing trouble when it's there. So we come to a natural sequence of questions the answers to which can increase the chances of achieving that elusive solution to diseases and pest problems:

1. Are my plants healthy?
2. If not, what is the cause of their trouble? Animate or inanimate? Disease or pest?
3. What can I do to rid my plants of their enemies?
4. If I can't decide, where can I go for help?

The answer to the first question depends on knowledge of the healthy characteristics of the varieties planted which can be gained in any number of ways. Visits to other gardens, looking at nursery catalog illustrations (judiciously), or through illustrated garden books are helpful.

The answer to the second is the most difficult of all and it is small comfort indeed to know that in general plant pathologists work with diseases and entomologists work with insects. (As a matter of fact many insects cause diseases and entomologists may be quite concerned with creatures that are not insects!) Plant diseases are generally considered to be harmful changes in the inner workings of plants brought about by the relatively prolonged influence of certain environmental agents. Such harmful changes result in *symptoms,* such as stunting, yellowing, galling, wilting, spotting, or rotting. Now, it is very important to note that the symptoms are not the disease, but the results of the disease.

The *environmental agents* (causal agents, incitants) may be inanimate or animate, resulting in the so-called nonparasitic and parasitic diseases respectively.

It is equally important to note that the causal agents are not the disease either. As a matter of fact, many of the living incitants of plant disease spend only a small portion of their lives causing trouble. The remainder of the time they may be doing something quite acceptable, or resting up, or making life difficult for an entirely different sort of plant.

TYPES OF CAUSAL AGENTS

Presently we will go on to a consideration of the appearance of unhealthy plants which, of course, is the main clue for the amateur in diagnosing his general category of trouble. Brief mention should be made of the types of causal agents first. We will begin with animate ones. Here it would be helpful to recall that green plants occupy an exceedingly high position among all living things. By virtue of a single peculiarity of their inner workings, the entire living world is able to survive. This peculiarity is the physiological process known as photosynthesis, by means of which green leaves transform carbon dioxide, water, and light energy into one or more simple foods. Minerals from the soil are combined with the products of photosynthesis

and molded into still other and more complex foods. On this source of food-energy virtually all other creatures depend, including the parasites. It is not surprising then that the same general groups of organisms that have representatives which are pathogenic to man also contain species pathogenic to plants. The main groups are bacteria, fungi, nematodes (round worms), and insects, two groups of non-green plants (and hence dependent on an external source of food), and two groups of animals (likewise dependent on an external source).

The first three groups have a characteristic in common that was of importance in delaying the discovery of their nefarious ways. This is their extremely small size. To be sure, any of them may be visible in the aggregate but at least portions of them such as fungus spores, or nematode eggs may be microscopic. The whole bacterium body, of course, is invisible without optical aids. Not much more than a hundred years ago, even when wefts of fungus threads (mycelium) had been observed time and again on the surface of diseased plants, it was thought by most scientists that they were products of the sick plants rather than causes of the disease. Indeed, it is difficult to believe that a single microscopic spore that is blown by the wind or splashed by the rain can alight on healthy green foliage, germinate like an infinitesimal seedling, push Lilliputian branches through the waxy coat, then between cells or through cells, scavenging food, dissolving walls, releasing toxins, disrupting photosynthesis, killing tissues, then erupt once more and thrust into the air a quarter million spores of its own — all within a few days' time!

Bacteria

Most of the pathogens (living organisms that can cause disease) of man are species of bacteria. This is not true of plant pathogens. One of the most famous controversies between scientists was in full sway only some 80 years ago over whether or not bacteria could cause plant diseases at all! Now it is known that some 300 species of these microscopic one-celled plants do just that. The types of diseases and symptoms are diverse. Many of them have been limiting factors in the production of crop plants and some of them are very serious in ornamental plantings. Fireblight, for example, eliminated commercial pear production in the Midwest, and even now causes great damage to several varieties of apples in that area as well as to pears on the West Coast. Bacteria are carried from cankers on stems to young flowers which then die back along with part of the twigs. From these new diseased areas bacteria are carried to other tender shoots where the process is repeated. Frequently an orchard appears to have been scorched by a giant blow torch. The same species of bacterium may cause similar symptoms on a number of Rosaceous ornamentals.

Any part of a plant may be affected by bacterial pathogens. Some cause local dead areas (necrotic lesions); some get in the vascular tissues, resulting in interruption of water and food transport and causing wilts; others induce the host plant to form more and more cells resulting in large tumors or galls on roots or stems. Indeed, one of the gall diseases has been the subject of intensive study for a number of years, since there is much to be learned about tumor induction in general if a thorough understanding of such diseases of man is to be attained. This disease is called crowngall, for the overgrowths are commonly located at about ground level. Diseased nursery stock is always condemned, frequently at considerable monetary loss, when this disease is discovered, as it is one of the most difficult of all to control.

The bacteria usually overwinter in or on host tissue. When weather conditions are warm and moist in Spring, reproduction of the bacterial cells is resumed at an extremely rapid rate, often resulting in the formation of a slimy ooze on twigs or other parts. The cells are transferred to new host plants by splashing rain; or by insects, tools, and implements; or in the seed from which a new plant arises. Some bacterial diseases are easy to control; others exceedingly difficult.

Fungi

The fungi are a vast and varied assemblage of non-green plants. (Some people include bacteria in the same group with the fungi). Two of the most familiar representatives are the noble mushroom, companion in perfection with the beefsteak; and the filamentous bread mold, insidious invader of the staff of life. Both of these are saprophytes; that is, they obtain their food from dead organic matter. Both form spores in fruiting bodies. In the case of the mushroom, a "higher fleshy fungus," the fruiting body is large, intricate in design, and soul-satisfying in flavor. It arises, however, from a very extensive weft of vegetative mycelium or threads buried in the substratum. This mycelium resembles that of many other fungi, including the bread mold. The fruiting structure of the latter is very simple in comparison, consisting of a minute stalk topped by many many spores in an ephemeral sac. Some idea of the numbers of spores which may develop can be obtained from the familiar green mold on oranges. That green powder which puffs about is composed of billions of spores.

The plant pathogenic fungi are not confined to any one of the major groups of fungi. Some have complex, fleshy fruiting bodies, others have not. Most form spores of some kind. Indeed the rust fungi may have as many as five different types of spores in their complex life cycles. In addition to variety in structure, there is extreme variety in feeding habits. Some are fastidious to the extent that they can complete their life cycles only on the living host plant, perhaps being restricted to only one or a few species of host at that. Some affect only certain parts. Others are omnivorous, existing from year to year entirely on non-living materials, becoming parasitic only when a host plant is weakened by some other sort of disease or by injury. Another type of omnivorous fungus may parasitize plants from hundreds of different species.

As you might expect, the symptoms of the diseases incited by these organisms are variable too. Any part of a plant may be attacked above or below ground. Some are wilters, some are spotters. Some are blighters, others rotters. Some cause overgrowths in number or size of cells. Others cause undergrowth as in stunting or chlorosis (abnormal deficiency of green pigment). Some fungi, like those causing damping off of seedlings, kill their host plants outright and promptly. Others live in relative harmony with the green plants, obtaining food and a place to stay at little or no expense to their hosts, like the powdery mildew fungus on lilac. Since the fungi are living things, there is also a considerable amount of activity among themselves, resulting in the formation of new races or biotypes with new combinations of characteristics. The same can be said for any of the major groups of pathogens, of course.

Nematodes

The nematodes are members of one of the major groups of invertebrate animals called the round worms. Their bodies are usually long and slender and there are large ones as well as small ones. Certain members of this group are parasites of man and other vertebrate animals, such as the one of common occurrence in pork that causes trichinosis. The pinworm is another. Plant parasitic nematodes are in general quite small. The largest of them can just barely be seen with the unaided eye. All of them are thought to be obligately parasitic; that is, they obtain food only from living tissues. They are well equipped for such a role, as each possesses a built-in miniature hypodermic needle that can puncture cells and extract juices. A good many of them are sedentary, living in or attached to the host plant. Others wander around inside the tissues channeling their way from place to place. Still others are the grazing type, puncturing from the outside, feeding for awhile, then moving along to greener pastures. Although the damage caused by some of these creatures has been known for a long time, recent research has revealed that there may be far more parasitic species than imagined before. Furthermore, it has already been found that attacks by nematodes may completely destroy natural resistance of plants to certain fungi and bacteria. Most of the nemas attack underground parts, but there are some that feed and reproduce in stems, leaves and flower parts. The eggs, larvae or cysts of certain representatives are extremely resistant, surviving for years and years in soil or plant parts.

Chewing Insects

Insects affecting plants have come to be thought of mainly as "pests." This is regrettable especially when the plants concerned are perennials. One reason this jargon has developed is that a good bit of insect damage, especially to crops, is not the result of disease at all. Let's consider the general types of insects and their relatives that harm plants. There are the chewers, those voracious creatures such as grasshoppers, caterpillers, beetles, borers, grubs, wire-worms, and leaf miners. The grasshopper alone has been called the principal grazing animal of the world. Whether or not they may cause disease is somewhat obscured by the fact that there are such severe economic losses to crop plants, many of which are annuals. The yields can be reduced enormously. Now, yield reduction is often a symptom of disease, but in this case, yields are not necessarily reduced through alteration in the food making or storing capacities of the plants. To the contrary in many instances the yields have been amputated (ambushed?) and consumed by the wrong parties. This does not alter the fact, however, that these jumping, crawling, flying appetites do cause disease. The removal of significant portions of the green foliage of plants, for example, obviously reduces their capacity for food making. Among perennials this leads to gradual reduction in vigor if the attacks are repeated year after year. Resistance to other organisms and environmental conditions is reduced.

Many of the chewing insects kill whole plants without removing large portions. Among them are the cutworms and grubs living in soil or near the soil line. Others, by their activity in vascular tissue, may interrupt water transport causing wilt symptoms.

Sucking Insects

The other main feeding type of 6-legged creatures, the sucking insects, causes a wide variety of

symptoms. Aphids, leaf hoppers, scales, mealy bugs, and spittlebugs, all insert their mouth parts into the host plant and suck juices from it. The appearance of the victim is altered in many ways. When young succulent foliage is attacked, for example, contortion of the developing shoots and leaf blades follows. Others, through their many minute punctures on leaves, cause an overall chlorosis, stippling, or bronzing. Some apparently secrete a toxin into the host plant, as do the potato leaf hoppers. The Harlequin bug and squash bug cause almost immediate wilting of the entire host plant soon after they feed in a localized area of the stem. Some cause galls of roots, leaves, or stems thus revealing a profound localized change in host physiology. (This also happens after many species of wasps have inserted their eggs into plant tissue.)

Mites

Now would be a good time to mention a group of insect relatives that are serious enemies of plants. These are the tiny mites and spider mites. If you really want to jolt that hardware store clerk, go in and ask for an acaricide. Since mites are not insects and since special means of control are frequently necessary, the purists call the chemicals which do the trick acaricides after the name of the group to which the mites belong, Acarina. Uncle Sam takes a much more commercial view and calls them insecticides. At any rate, if special control measures are sometimes necessary, you can rest assured that what the animals do to plants is of considerable concern. They are very small (barely visible) and feed on many different plant parts. They may cause leaf distortion, bronzing, and shedding. Others injure fruits. One group causes severe overgrowths in flower parts and buds. Frequently they form a thin veil of web on the underside of leaves.

Dissemination of Pathogens by Insects

As if this grand miscellany of insect damages were not enough, there is yet another type of insect villainy that does not bring joy to him who cultures plants of any kind. Many species of insects are great beasts of burden that carry within or on their bodies a variety of other plant pathogens. These they may deposit on the surface of appropriate hosts during their wanderings, or they may actually inject them into the plant tissues. Frequently the arrangement between pathogen and insect is not one of mere chance mechanical transport, but a highly specialized relationship resulting in the shelter of the pathogen over winter, followed by the careful deposit of it at the proper site at the crucial moment. Sometimes the disease incitants may actually increase in number within the body of the insects. Many of the bacterial or fungal pathogens so transported may be disseminated by other means as well, but there are a number of exclusive ones that can be sheltered and disseminated only by such insects. Naturally, then, control of the insect pays dividends by preventing the bacterial or fungal disease.

Viruses

While we're on this general subject it is a good time to mention another very large and important group of causal agents of plant diseases. At the beginning we mentioned the somewhat obvious fact that causal agents of disease could be classified into two broad categories, living and non-living. At this juncture we must confess that we just don't know whether or not members of a large group of serious disease incitants are living or not. These are the viruses, those extraordinary complex protein molecules that induce host plants to form more of them and cause damages worth millions in the process. Insects, leafhoppers and aphids especially, are extremely important in disseminating viruses and injecting them into plants. Again, some relationships are casual, others intimate. So many of the viruses are transmitted this way, that insect control is of prime importance. Other plant viruses can be transmitted through wounds such as those caused by grafting or cultivating instruments or merely by brushing a plant with a shirt sleeve. They cannot be cultured on artificial media.

Symptoms of virus-incited diseases are fully as diverse as those of any of the diseases caused by parasites, such as spotting, stunting, chlorosis, wilting, rotting, and tumor formation. In addition there are a number of devious subtleties. The commonest site of symptom expression is the newest growth. Young foliage may be distorted beyond recognition, yet older parts, which nevertheless contain virus particles, can remain apparently healthy. One of the commonest types of symptom is called mosaic. Leaves are mottled with light and dark green patches, some of which may be raised. Another type closely allied to mottling is variegation. Bright yellow or white spots occur on leaves or flowers. You may have some virus-diseased plants, for a number of exotic variegated ornamentals are not variegated as a result of their own inherent characters, but because a virus has somehow contaminated a non-variegated variety and the diseased stock has been perpetuated by vegetative propagation.

Sometimes there is no visible evidence that a plant contains a virus, yet the virus can be transmitted to another host plant where symptoms occur.

A considerable number of diseases have been described that are caused by two viruses acting together, the combination resulting in a set of symptoms quite different from those characteristic of the effect of either virus alone.

Non-Living Causal Agents

Subtle as some of these symptoms may be, they cannot match those of the diseases caused by truly non-living environmental factors, where excesses and deficiences are often relative rather than absolute. This makes them no less important as far as the health of the plant is concerned. In considering the vagaries of the non-living environment of plants it is well to bear in mind that most higher plants live in two different worlds at the same time: the air and the soil. How many living things do you know of that spend most of their lives under such circumstances? On the one hand the environment is relatively dry, filled with gases of various sorts, sparsely inhabited by a few flying things or tiny blown about creatures and subject to frequent large variations in temperature. The lower regions, however, are dark as can be, moist, crowded with mineral and organic matter, and teeming with small plants and animals. Add to this the wonder of intertwined activities of the top of the plant and its roots, and the stage is set for a display of reactions giving rise to every conceivable overt symptom. The most delightful symptoms of interaction, of course, are the richness of foliage and vigor of growth of the plant able to handle variation in its environment. When water losses and food making activities of the foliage are in balance with the water and mineral intake, and food utilization of the root system, all's right with the world. But let there be a serious imbalance, as when the air is exceedingly dry and the ground not correspondingly moist, normal growth ceases. So it is that water shortages, mineral deficiencies or excesses, and temperature extremes cause many symptoms of disease. Plants wilt, become mottled, spotted, chlorotic or bronzed, shed leaves prematurely, get cankers or distorted fruits, all through the agency of *relatively* extreme variations in nonliving environment.

Diagnosing

It now appears that the only causes of diseases not operative in the plant kingdom are the psychosomatic ones! This invites a discussion of the weeping willow, but we have yet to dwell a little on a serious question. How in the world do you find out which of all these agents that may induce the same symptom development is actually to be blamed in a particular instance?

Take heart. Many plant troubles, such as black spot of rose, can be identified by their very typical symptoms.

There is another bit of encouragement. Symptoms alone are not the whole story. Anyone who has seen powdery mildew of lilac can spot the same disease of just about any other type of plant there is even though many different species of related fungi cause the disease. Similarly, anyone who has seen the orange rust on hawthorn or apple, might suspect correctly that the strange orange powder-filled protuberances on pine needles are caused by a related fungus. What is it that indicates causal agent in these two examples? It is the causal agent itself. The symptoms of a powdery mildew disease often include yellowing or browning of leaves and distortion of young shoots and buds (as on roses), but these are symptoms that could be caused by any number of things. Aphids on roses, for example, also cause shoot and bud distortion. It is that powdery white coating on the upper surface of lilac leaves that distinguishes the disease, and that coating is the mycelium of the fungus itself. And it is the sight of the aphid itself that is the tip-off to its own damage on roses. So, in addition to symptoms of the disease that help us in solving the identity problem, there are the signs of the culprits themselves. Often they don't leave the scenes of their crimes. Leaf spots, for example, may have dark pin-point specks in their centers — a suggestion that a fungus has caused the spot and has formed its minute fruiting bodies there.

Yet another comfort is the fact that each of the plants found in the garden has its own family of most common troubles which have been described and illustrated for the amateur diagnostician by several able professionals. Specific control measures are given for each trouble. One of the most faithful of all the gardener's literary friends has been Dr. Cynthia Westcott. Several of her books are cited at the end of this article. Another recent publication by a plant pathologist is Dr. A. W. Dimock's "The Gardener's A B C of Pest and Disease," concise, down-to-earth, practical, and entertaining as well. Dr. P. P. Pirone has also written for the amateur. If you are curious about plant diseases in general and how they have influenced man's progress from ancient times onward, take a look at the books by E. C. Large and Stevens and Stevens.

Control Recommendations

Recommendations for control in any book on plant diseases are based on principles that have been developed from years of research on the life histories and means of dissemination of causal

agents; on the diseases and the influence of environment on them; and on the resistance of different plant varieties to insects and disease, as well as on chemicals and their application methods.

These principles of plant disease control will be discussed at greater length in another article, but it should be emphasized here that the main objective behind all control methods is to *prevent* disease, either to keep it from developing at all or to curtail further development once begun. No amount of fertilizing, watering, or spraying with exotic brews will make a dead branch come back to life! This is why the gardener who really enjoys his hobby develops a sharp eye and inquisitive reading habits. "One swallow does not a summer make," but one leaf spot may be a vision of things to come!

READING SUGGESTIONS

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Plants for Associates

MARY O. MILTON, PROPAGATOR

In the past the Arboretum has distributed plants to a relatively small number of Associates. Now our number of Associates has increased to a point where there are widely varied garden types to be considered and one general plant type no longer meets the requirements of the majority of gardens. Therefore, we would like to have you write to us and indicate the type, or even specific plant you feel is needed for your particular soil, space, and landscaping plan.

Although we may not be able to meet each personal request we do of course want to furnish suitable plants for a greater number of Associates.

You might include in your list plants which you have found difficult to obtain through commercial sources. And of course your request for a less well known plant might well bring it to the attention of others who have either not known the plant at all, or perhaps knew the plant but had not considered it as having merit for use in a home garden. In this way a more general acquaintance and appreciation of the less well known plants can be made.

While we are inviting your correspondence on the above we would like to know, too, your thoughts on changing the time of our plant distribution from Fall to Spring. Our greenhouse and nursery area is limited and a great deal of labor is involved in repeated repottings. It is necessary, therefore, to limit the size of plants distributed to that which will fit into a four inch pot. This means that the plant you receive is usually about two years old and has spent its entire life either in the greenhouse or in a coldframe. Since most plants require a period of "hardening-off" to enable them to adjust to a sudden change in temperature you are faced with either coddling them through the winter in a sheltered place, or taking a chance and planting them out in the Fall. Last year's instructions for carrying the plant through the winter were somewhat involved for some of the Associates; many had no suitable place to keep them, and as a result some plants were killed during the winter. It is thought, then, that Spring rather than Fall distribution would be better.

In order that your letters or cards in answer to the above can be quickly separated from the general Arboretum correspondence, please address them to the Propagator.

Arboretum Activities

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She served for a number of years as Research Associate at the O.S.U. Research Foundation and immediately prior to coming to the Arboretum had been engaged in teaching and research at the University of Minnesota.

The appointment of Dr. Allison makes possible the establishment of an active research program in experimental plant pathology and mycology at the Arboretum. Particular attention will be given to the diseases of woody ornamental plants and for the first time in many years the Arboretum will be in a position to give technical advice to the public on matters relating to this important subject.

Readers of this issue will be introduced to Dr. Allison through the medium of her informative article "What's Your Trouble?"

Dr. Li Visits England

On August 26th, Dr. H. L. Li, Taxonomist on the Arboretum Staff, left with his family for a three months' stay in England.

Dr. Li is the recipient of a grant from the National Science Foundation for the purpose of studying the trees and shrubs of Formosa. His trip to England will enable him to study the rich collections of Formosan plants at Kew and the British Museum. He will also visit a number of large herbaria on the continent.

Drug Plant Garden

It is a pleasure to report that the Garden Club of America at its forty-fourth annual meeting held at Winnetka, Ill., in May presented its Founder's Fund Award to the Morris Arboretum for the purpose of establishing a Medicinal Plant Garden. This award of $2200 will enable the Arboretum to carry out a project which has long been entertained, namely, the development of a living collection of the important drug plants of the world.

Many of the famous gardens of the sixteenth and seventeenth centuries were primarily collections of medicinal herbs. Indeed systematic botany may be said to owe its beginning very largely to the attempts to describe and classify the therapeutic properties of plants. It is therefore highly appropriate that today, when there is such a renascence of interest in natural products as the source of drugs, some attention be devoted to this important group of plants.

The new Drug Plant Garden will be located on a gentle slope just below the Rose Garden, where it can readily be viewed by visitors. Of unusual interest will be the fact that in addition to hardy species, such as Digitalis and Aconite, it will contain numerous tropical and subtropical drug plants like Ipecac, Quinine and Rauwolfia. The latter group will of course, be moved into a greenhouse during cold months.

It is expected that this garden will be of interest to students from schools of medicine and pharmacy as well as to the general public. A descriptive pamphlet telling of the medicinal value of each species is being prepared and will be available for distribution when the Drug Plant Garden is formally opened.

A future issue of this Bulletin will carry a detailed account of the Garden with the information concerning the date on which it will be ready for inspection.

The Arboretum is most grateful to the Officers and Members of the Four Counties Garden Club and the Garden Club of Allegheny County who sponsored this project.

Survey of the Grounds

Visitors to the Arboretum this summer will have noticed large numbers of wooden stakes driven into the ground at regular intervals. This is part of a much-needed survey of our 170 acres that is being conducted by a team of Civil Engineering students from the University's Towne School.

The entire property is being laid out in grids or squares 200 feet on a side. This autumn the wooden stakes which mark the corners of these squares will be replaced by concrete markers or "monuments" set flush with the ground in order to facilitate mowing.

Once this survey has been completed it will be possible to prepare a set of master maps, one for each square, on which the exact position of every plant will be shown. These maps which will be drawn on linen, with a scale of one inch equaling ten feet, will constitute a valuable addition to our archives, and will enable us to record with precision the location of each of the many thousands of individual trees and shrubs.

Renovation of Fernery

One of the truly unique features of the Arboretum is the tropical fern-house which was designed by Mr. Morris and constructed near the beginning of the century. In recent years the roof of this structure had become so weakened that it was necessary to close the Fernery to the public.

This summer our able builder, Mr. Thomas Carney with the aid of two assistants has completely reconstructed the roof, using new steel supports and struts and replacing all of the wooden frames with California redwood. Motorized vent control is being installed and a special type of new glass is being used throughout. When the Fernery is re-opened this Autumn it will be tighter and stronger than ever and visitors once again will be able to enjoy one of the Arboretum's most attractive features.

Shade Tree Conference

The National Shade Tree Conference held its 33rd annual meeting at the Sheraton Hotel in Philadelphia from August 26 to 30. Several members of the staff attended these meetings and a number of participants visited the Arboretum.

Upon invitation the Arboretum arranged a small exhibit which was set up in the Educational Exhibition Area at the hotel. In it we featured a display of dwarfed tree materials or "bonsai" kindly made available by Dr. Li from his personal collection. We also featured, with illustrative material, two articles which have recently appeared in this Bulletin, namely, Dr. Li's paper on "The Origin and History of the Cultivated Plane Trees" and Dr. J. W. Wright's article entitled, "Cultivated Firs in the Philadelphia Area."

According to the Chairman of the Exhibits Committee the Arboretum's display elicited many favorable comments and was by far the most educational of all the exhibits.

The Summer Course

For the third successive summer there was conducted at the Arboretum a college-level course devoted to the Identification of Woody Plants. This year the course was one of a series of six courses to which were admitted participants of the National Science Foundation's Summer Institute for High School Teachers of Science and Mathematics. As a result nine members of a class of twenty were high-school teachers who were enrolled as N. S. F. Scholarship holders. This group included representatives from as far west as Michigan and as far south as North Carolina. Four other members of the class were graduate students of Landscape Architecture who took the course in order to acquire a better knowledge of plant materials.

As in the past, the formal laboratory work was conducted on the ample verandas of the Gates Building and the class spent approximately two hours each day on the grounds becoming acquainted with the living plants. In addition to the day-by-day work of identification, the students received instruction in such related subjects as propagation, disease recognition and control, ecology, forest genetics, and a number of others.

J. M. F., Jr.

Better White Pines

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breeding work at the Morris Arboretum. There are ten exotic white pines that have been grown for a sufficiently long time in this region to indicate their hardiness. These are not all timber types but it is possible that even the non-timber trees may carry desirable inherent qualities such as resistance to insects or disease. We expect to test those exotic species with good timber form in their native range, in forest plantations in the Northeast.

Our controlled white pine breeding methods at the Morris Arboretum are essentially the same as those used in the breeding of agricultural plants. The female flowers are covered with a bag before they are receptive to pollen (fig. 21) to protect them against natural pollination. Pollen collected from male flowers (fig. 22) of the desired male parent, is stored in cotton-stoppered vials (fig. 23) in the refrigerator at 25 percent humidity until the female flowers are receptive (fig. 24). Pollination is accomplished by puncturing the covering bag (fig. 25) and blowing a small amount of pollen from a pollen-filled pipette (fig. 24) directly on the open flowers.

Tree breeding requires patience; compared to agricultural crops, trees grow slowly. The seedlings derived from controlled pollination are still too young to evaluate the results of our breeding work. It will be at least five years before estimates on probable growth and pest resistance will be available.